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TEST OF CURTISS EIGHT-CYLINDER MODEL OX-5 ENGINE RATED AT 90 HORSEPOWER AT 1,400 REVOLUTIONS PER MINUTE

(POWER PLANT SECTION REPORT)

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OBJECT OF TEST.

The object of the test was to obtain reliable data for use by airplane designers on the performance of the Curtiss OX-5 engine.

SUMMARY OF RESULTS.

Normal brake horsepower at full throttle, 98.5 B. H. P. at 1,400 R. P. M.

Fuel consumption at normal horsepower, 0.490 pounds per B. H. P. hour.

Oil consumption at normal horsepower, 0.0228 pounds per B. H. P. hour.

Normal brake mean effective pressure, 111.0 pounds per square inch.

Total weight, dry, 377.0 pounds.

Weight dry per B. H. P., 3.83 pounds.

CONCLUSIONS.

In view of the eminent reliability of this type of engine during the World War no comment on this engine is necessary. From a technical standpoint the general performance and fuel and oil consumption of the engine are very good and it is well adapted for use in training airplanes. The engine developed no trouble of any kind during the test and revealed no point of excessive vibration. The carburetion appeared to be good at all speeds. Plugging one oil breather did not cause the loss of any oil or affect the engine operation in any way.

DESCRIPTION OF ENGINE.

The engine tested is a Curtiss Model OX-5 Air Service Serial No. 10536, eight-cylinder, Vee type, designed with a staggered cylinder arrangement more clearly understood by reference to figure 3. It is of the four stroke cycle, water cooled, tractor type and uses aviation gasoline as fuel. The propeller is directly driven from the crankshaft. The engine is one of several types designed by the Curtiss Aeroplane & Motor Corporation of Garden City, Long Island, N. Y. This particular engine was manufactured by the Willys-Morrow Co. (Inc.), of Elmira, N. Y. For additional illustrations see figures 1 and 2.

The characteristic features on this engine are the staggered cylinders, side-by-side connecting rods, the unique push rod arrangement and the location of the carburetor at the rear of the engine.

A great many handbooks and much information is available on this engine but perhaps the best is "The Curtiss Standard Model OX Aeronautical Motor Handbook" issued by the manufacturers. For more detailed information on various points not covered in this report the reader is referred to the handbook just mentioned.

METHOD OF TEST.

The test of this engine followed more or less closely the "Instructions for Conducting Standard Engine Tests." No part photographs, weights, or dimensions were taken. The following runs were made:

Two full-power runs.

A friction horsepower and compression pressure run.

A carburetion run.

A one-hour fuel and oil consumption run.

A water pump capacity run when pumping through the engine.

The fuel used for the test was domestic aviation gasoline and was measured by volume. The oil used was within the limits set by specification 2-23B. The power was measured by a Sprague electric dynamometer, the electrical resistance of which was adjusted to absorb the power output of the engine. For further details on the method of testing see Engineering Division reports, Serial Nos. 1506 and 1507.

The "carburetor vacuum" (see figure 5) was taken at the throat of the right-hand venturi tube.

ENGINE DATA.

Bore	4 inches.
Stroke	5 inches.
Compression volume	16.05 cubic inches.
Total cylinder displacement	502.80 cubic inches.
Compression ratio	4.92 to 1.
Rotation of propeller (facing propeller)	Counterclockwise.
Firing order	1-2-3-4-7-8-5-6.
Method of numbering cylinders	See figure 3.

Timing, actual average:

	Opens.	Closes.
Inlet	17° ATC	41° ABC
Exhaust	49° BBC	3° ATC

Power plant weight:[1]

	Pounds.
Engine weight, dry	377.0
Power plant constant weight	28.10
Cooling system	64.03
Tankage	59.75
Fuel, 2½ hours sea level full throttle	118.00
Oil, 2½ hours sea level plus 22 pounds reserve	27.50
Total	674.38
Weight per horsepower (power plant)	6.85
Weight per horsepower (engine, dry)	3.83

Carbureter setting:

	Mm.
Chokes	22
Main jets	1.20
Compensators	1.00

[1] See power plant weight table in Engineering Division report serial No. 1506.

FULL-POWER RUNS.

FIRST RUN.

Actual— R.P.M.	Actual— Brake load, lb.	Actual— B. H. P.	Corrected— Torque lb.-ft.	Corrected— Hp.	B.m.e.p. lb. per sq. in.	Water— Temp. °F. In.	Water— Temp. °F. Out.	Oil press. lb. per sq. in.	Carb. air temp. °F.	Man. vac. in. Hg.	Carb. vac. in. Hg.	Mix.[1] cont. position.	Fuel cons. Lb. per hr.	Fuel cons. Lb. per hp. per hr.
850	199	56.4	363.0	58.8	108.9	150	170	58	50	0.4	1.2	Full Rich	36.2	0.642
950	211	66.8	385.0	69.6	115.5	145	165	60	50	0.5	1.5	1.80	.....	.....
1,050	216	75.6	394.0	78.8	118.1	142	167	60	50	0.6	1.6	1.25	39.2	.518
1,160	216	83.6	394.0	87.2	118.1	150	164	63	50	0.7	1.8	1.65	.....	.....
1,230	214	87.8	390.5	91.5	117.1	155	170	62	50	0.8	2.0	1.5	43.6	.497
1,340	209	93.4	381.5	97.4	114.4	152	168	62	50	0.9	2.0	1.5	.....	.....
1,400	206	96.2	376.0	100.3	112.8	160	145	62	50	1.0	2.1	1.5	46.7	.485
1,490	200	99.4	365.0	103.6	109.5	170	158	60	50	1.1	2.3	1.5	.....	.....
1,620	192	103.7	350.5	108.1	105.1	166	156	60	52	1.3	2.5	1.7	51.2	.494

Average barometer, 28.70 in. Hg.

SECOND RUN.

830	210	58.1	384.0	60.8	115.2	155	170	57	60	0.4	1.1	1.5	37.5	0.646
940	217	68.0	397.0	71.1	119.1	156	170	55	58	0.6	1.4	1.5	.....	.....
1,040	220	76.3	402.5	79.8	120.8	156	168	58	56	0.7	1.5	1.5	41.3	0.541
1,110	215	79.6	393.4	83.2	118.0	160	178	60	56	0.7	1.6	1.5	.....	.....
1,200	216	86.4	395.2	90.3	118.6	156	170	61	56	0.8	1.8	1.5	43.3	0.501
1,330	210	93.1	384.0	97.4	115.2	148	160	60	56	1.0	2.0	1.6	.....	.....
1,420	206	97.5	376.9	101.9	113.0	156	168	60	56	1.1	2.1	1.5	46.9	0.481
1,540	200	102.7	366.0	107.4	109.8	160	149	60	64	1.1	2.4	1.5	.....	.....
1,590	195	103.4	356.8	108.1	107.1	174	154	60	61	1.2	2.5	1.5	52.3	0.506

Average barometer, 28.62 in. Hg.
[1] The control was full lean at 1.2 and full rich at 3.2.

PROPELLER LOAD RUNS.

FIRST RUN.

Actual— R. P. M.	Actual— Brake load lb.	Actual— B. H. P.	Corrected horse-power.	Water temp. °F. In.	Water temp. °F. Out.	Oil press. lb. per sq. in.	Carb. air temp. °F.	Man. vac. in. Hg.	Carb. vac. in. Hg.	Mix.[1] cont. position.	Throttle position.	Fuel cons. Lb. per hr.	Fuel cons. Lb. per hp. per hr.
1,430	205	97.8	100.4	156	170	62	58	1.1	2.2	1.5	10	47.9	0.490
1,190	148	58.7	60.3	162	174	61	60	6.4	0.8	1.5	1.5	29.9	.509
1,010	105	35.4	36.4	162	174	59	62	9.9	0.4	1.5	1.0	21.4	.604
820	67	18.3	18.8	160	168	57	64	14.6	0.1	1.5	0.9	15.2	.830

SECOND RUN.

1,410	201	94.5[2]	97.0	156	170	60	64	1.2	2.6	3.2	10	52.6	0.556
1,410	202	95.0	97.5	154	168	60	64	1.0	2.0	1.2	.....	46.0	.485
1,210	150	60.5[2]	62.1	158	170	60	64	6.5	1.0	3.2	1.4	33.1	.547
1,190	142	56.3	57.8	156	168	60	64	6.6	0.7	1.2	.....	29.3	.521
1,000	104	34.7[2]	35.6	154	166	64	68	10.6	0.4	3.2	0.9	23.0	.662
1,030	96	33.0	33.9	155	168	65	70	10.9	0.3	1.75	.....	20.1	.610
810	68	18.4[2]	18.9	150	161	60	72	17.0	0.1	3.2	0.7	15.5	.844
820	66	18.0	18.5	160	172	60	72	16.5	0.1	0	.....	12.8	.713

Average barometer; 29.14 in. Hg.

[1] The control was full rich at 3.2 and full lean at 1.2.
[2] The readings marked with (2) were with full rich mixture; the others were with best setting of the control at each speed.

FRICTION HORSEPOWER RUN.

R. P. M.	Corrected engine B. H. P. (from curve).	Friction load (lb.).	F. H. P.	F. M. E. P. (lb. per sq. in.).	Per cent mech. eff.	Comp. press. (lb. per sq. in.).	Water temp. °F.		Air temp.
							In.	Out.	
120	.....	.....	.....	.....	.....	78	.....	.....	.....
800	54.5	21	5.9	11.6	90.2	.....	156	168	50
900	64.1	21	6.6	11.6	90.7	.....	170	168	50
1,000	73.4	24	8.4	13.2	89.8	.....	168	168	50
1,100	82.2	25	9.6	13.7	89.6	.....	170	170	50
1,200	90.0	25	10.5	13.7	89.6	.....	170	170	50
1,300	96.3	27	12.2	14.8	88.7	.....	168	168	50
1,400	101.8	30	14.6	16.4	87.4	.....	170	170	50
1,500	105.8	31	16.2	17.0	86.7	.....	170	170	50
1,600	108.0	32	17.9	17.6	85.8	.....	175	175	50

Length of brake arm, 21 inches. Kind of oil used, U. S. Spec. 2-23B. Average barometer, 28.62 in. Hg.

ONE HOUR FUEL AND OIL CONSUMPTION RUN.

Elapsed time (minutes).	R. P. M. by counter.	Actual.		Corr. H. P.	B. M. E. P. (lbs. per sq. in.).	Water temp. °F.		Oil press. (lbs. per sq. in.).	Carb. air temp. (°F.).	Man. vac. in. Hg.	Carb. vac. in. Hg.	Mix.[1] cont. position.	Gas. cons.		Oil cons.	
		Brake load (lbs.).	B. H. P.			In.	Out.						Scale reading (lbs.).	Lbs. per hp. hr.	Lbs. per hr.	Lbs. per hp. hr.
0	.....	207	.....	.....	.....	153	168	60	54	1.0	2.3	1.5	110.0	.....	.....	.....
5	1,430	207	98.7	100.9	111.1	160	173	61	54	1.0	2.2	1.5	105.9	0.498	.....	.....
10	1,426	207	98.4	100.6	111.1	162	174	62	54	1.0	2.2	1.5	102.0	0.476	.....	.....
15	1,404	207	96.9	99.1	111.1	156	170	62	54	1.0	2.2	1.5	97.9	0.508	.....	.....
20	1,410	207	97.3	99.5	111.1	155	169	62	54	1.0	2.2	1.5	93.9	0.494	.....	.....
25	1,398	207	96.4	98.5	111.1	164	180	61	54	1.0	2.1	1.5	89.8	0.510	.....	.....
30	1,396	207	96.3	98.4	111.1	156	170	61	55	1.1	2.2	1.5	85.8	0.499	.....	.....
35	1,376	207	94.9	97.0	111.1	156	169	62	56	1.0	2.2	1.5	82.0	0.481	.....	.....
40	1,384	206	95.0	97.1	110.5	159	174	62	56	1.0	2.1	1.5	78.2	0.480	.....	.....
45	1,392	206	95.6	97.7	110.5	155	169	62	54	1.1	2.2	1.5	74.3	0.490	.....	.....
50	1,386	206	95.2	97.3	110.5	154	168	62	55	1.1	2.2	1.5	70.2	0.517	.....	.....
55	1,388	206	95.3	97.4	110.5	156	170	62	56	1.1	2.2	1.5	66.7	0.441	.....	.....
60	1,388	206	95.3	97.4	110.5	162	174	62	56	1.1	2.2	1.5	62.8	0.491	2.2	.....

AVERAGE RESULTS FOR ONE HOUR.

	1,398	206.6	96.3	98.5	111.0	158	171	62	55	1.0	2.2	1.5	47.2[2]	0.490	2.2	0.0228

[1] The mixture control was full rich at 3.2 and full lean at 1.2.
[2] Total for one hour.

Data for all runs: Length of brake arm, 21 inches. Kind of oil, U. S. Spec. 2-23-B. Fuel used (spec. grav.), 0.710 at 15° C. Average barometer, 29.27 in. Hg.

WATER-PUMP CAPACITY RUN.

Revolutions per minute.	Pounds per 15 seconds.	[1] Gallons per minute.	Revolutions per minute.	Pounds per 15 seconds.	[1] Gallons per minute.
800	26.5	13.1	1,300	41.75	20.6
	26.5	13.1		42.00	20.7
900	29.25	14.4	1,400	44.50	21.9
	28.50	14.0		44.75	22.0
1,000	33.50	16.5	1,500	48.50	23.9
	33.75	16.6		47.75	23.5
1,100	36.60	18.0	1,600	51.00	25.1
	36.00	17.7		50.50	24.9
1,200	39.25	19.3			
	37.50	18.5			

[1] Water temperature was 170° F.; 8.12 pounds of water per gallon at 170° F.

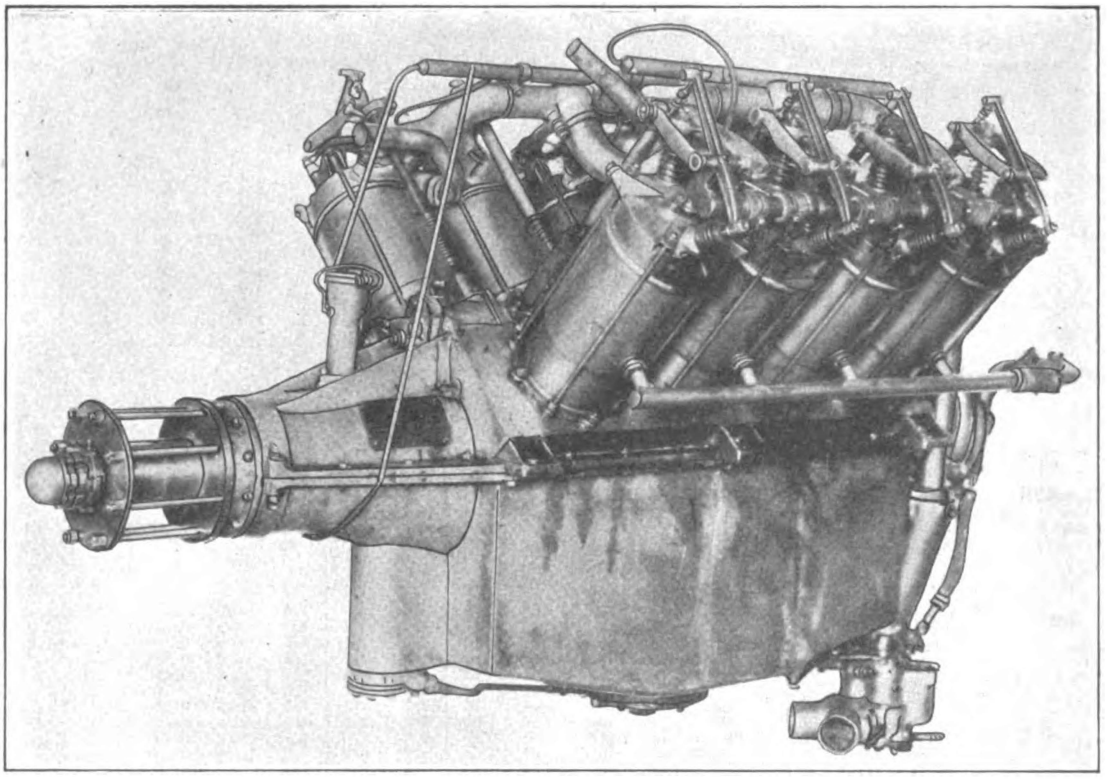

FIG. 1.—Three-quarter front view.

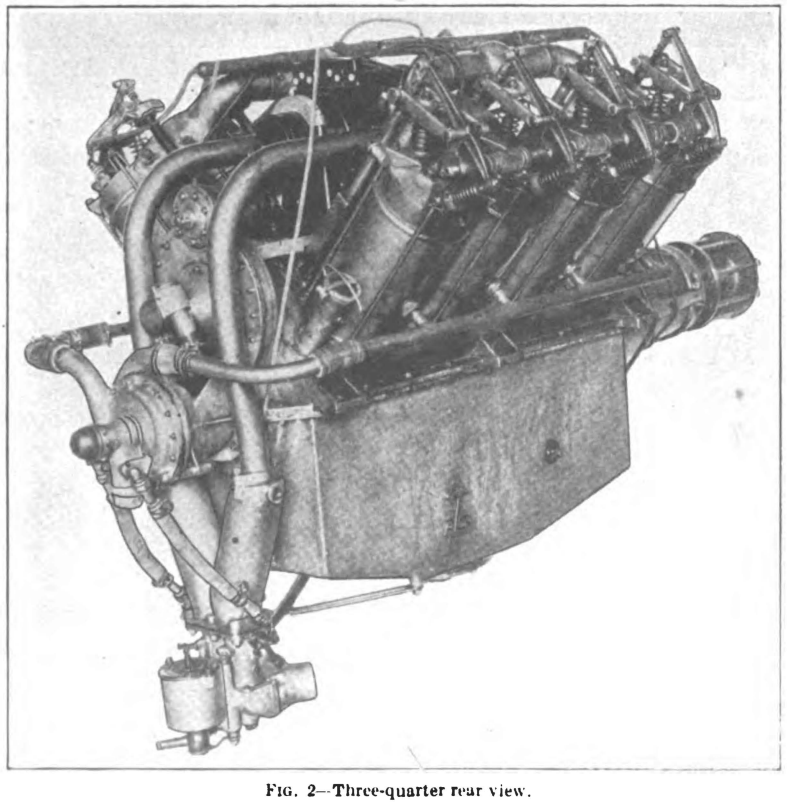

FIG. 2—Three-quarter rear view.

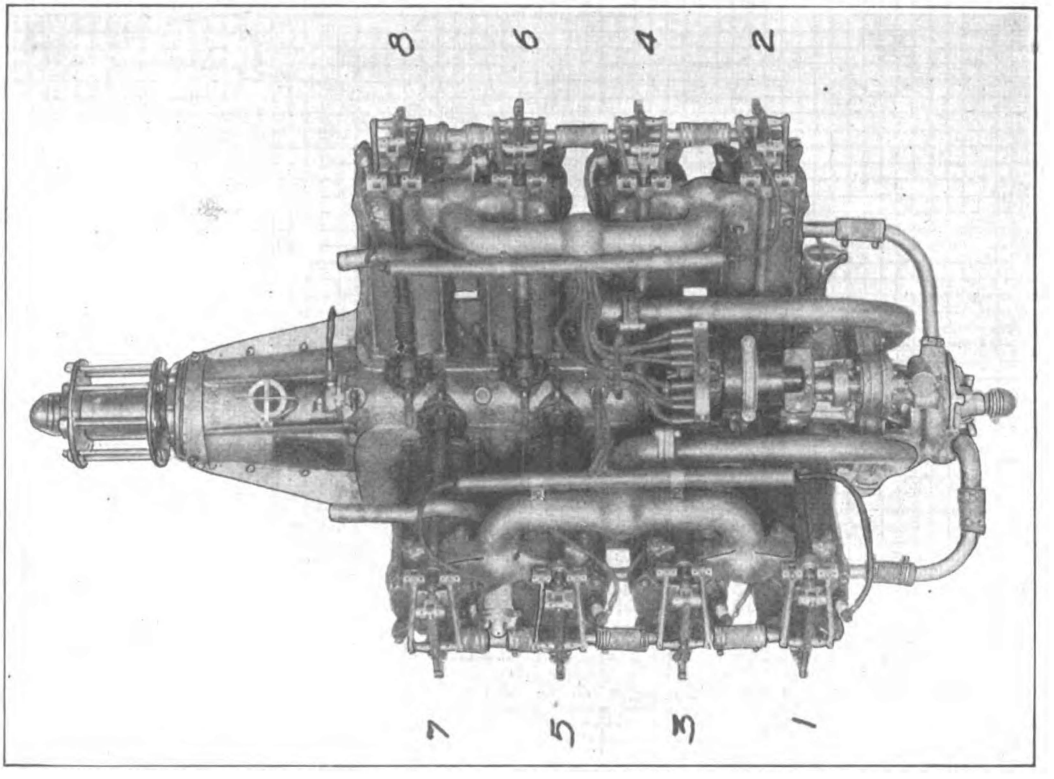

FIG. 3—Top view with cylinder numbers.

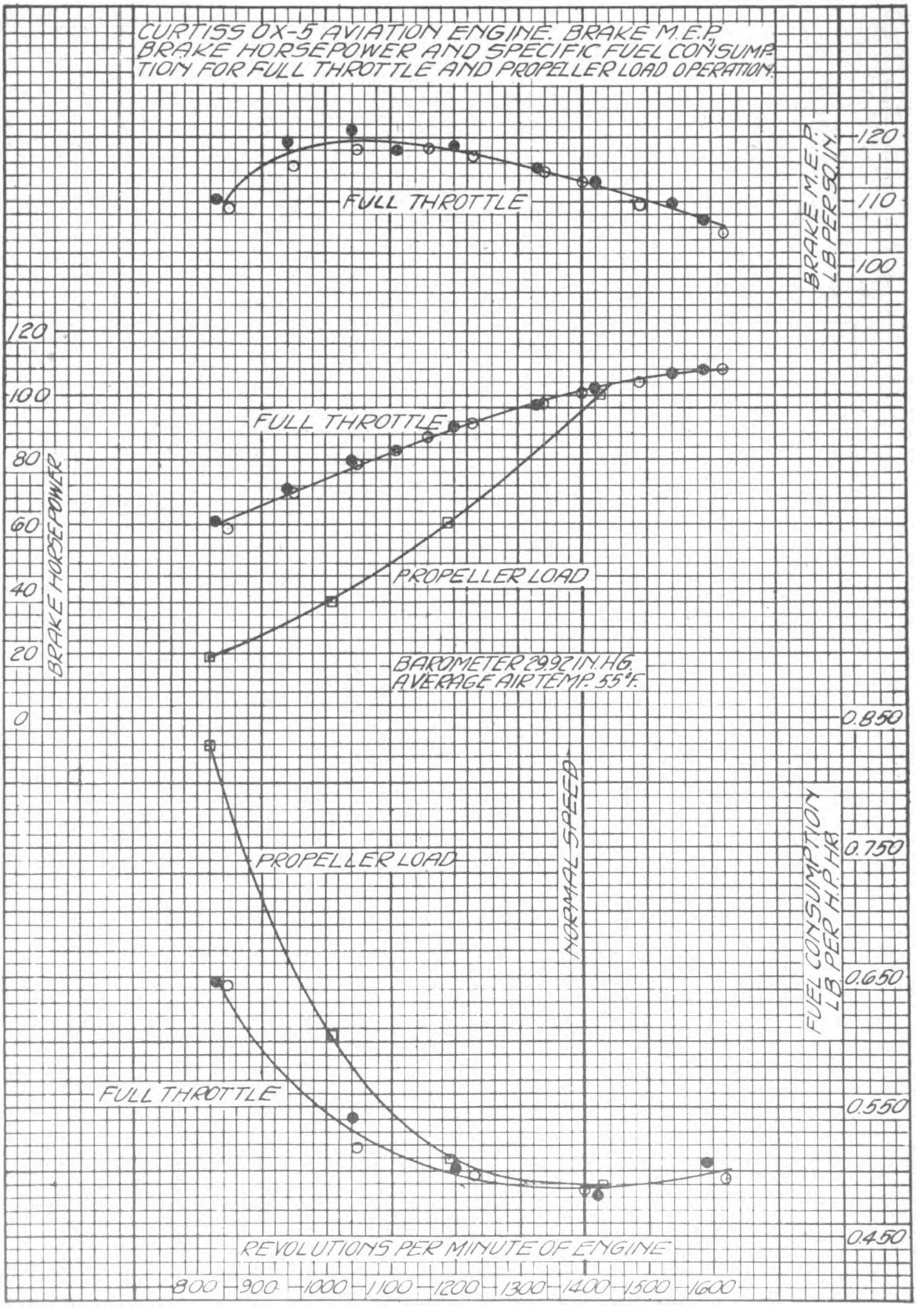

FIGURE 4.

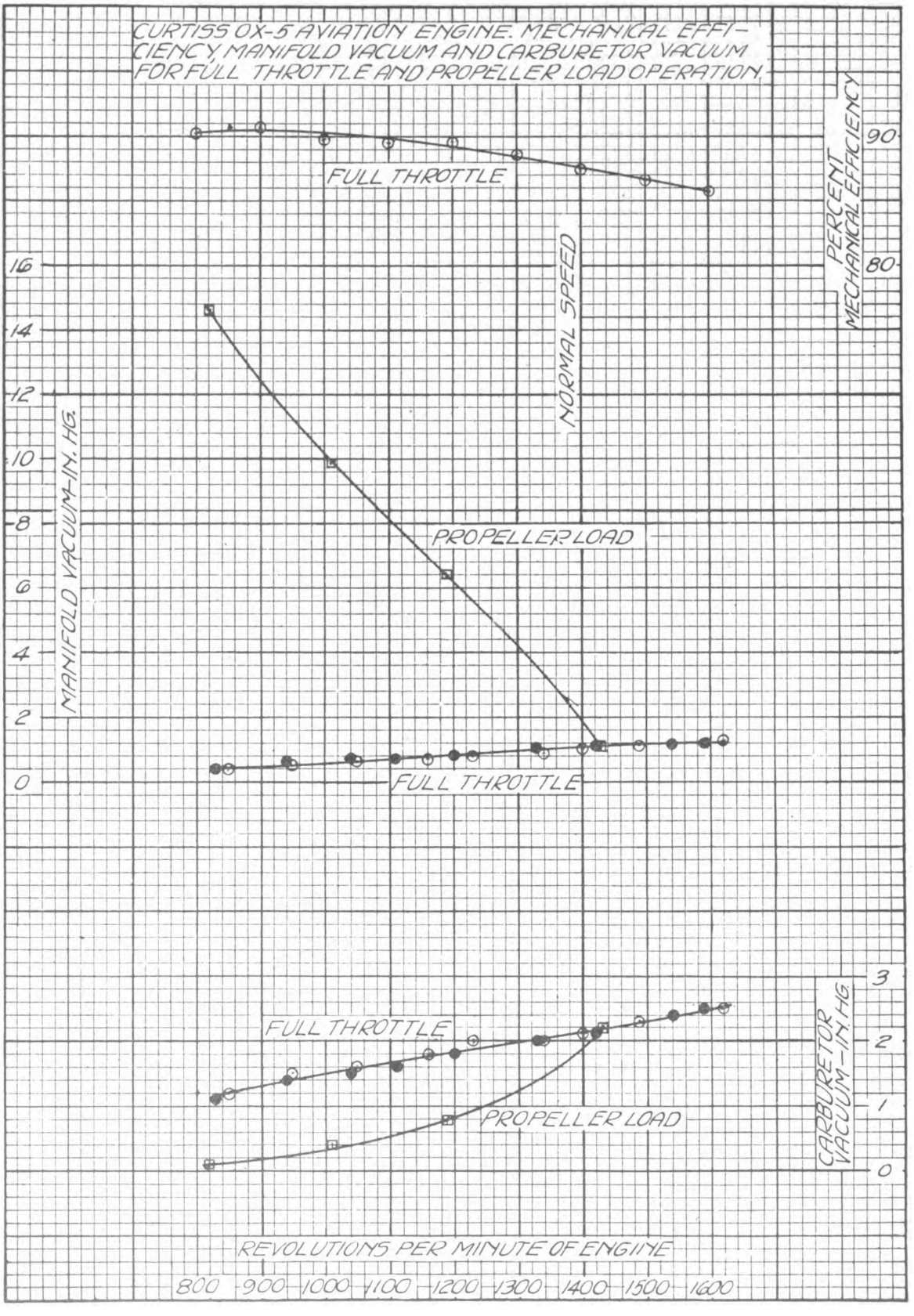

FIGURE 5.

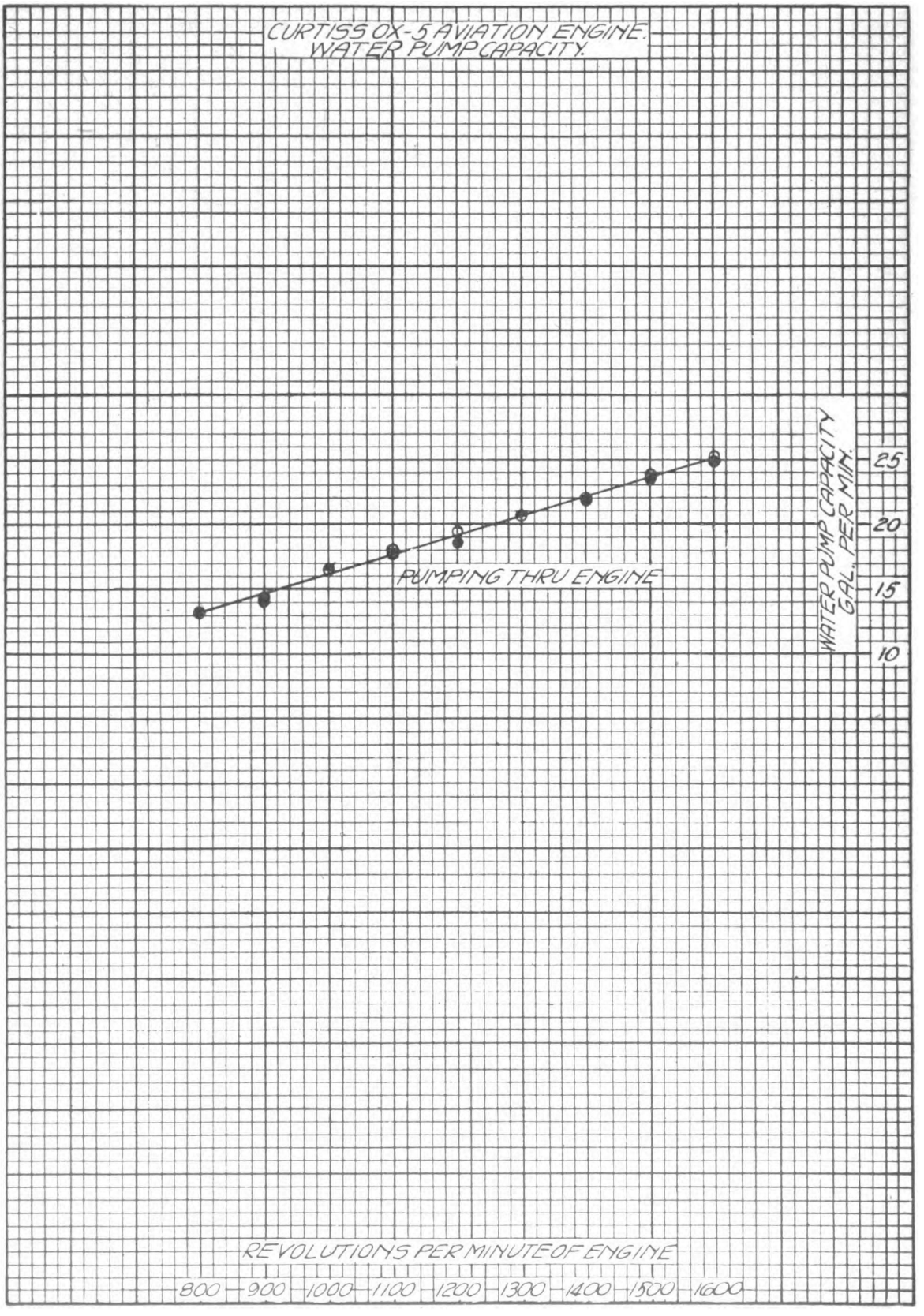

FIGURE 6.

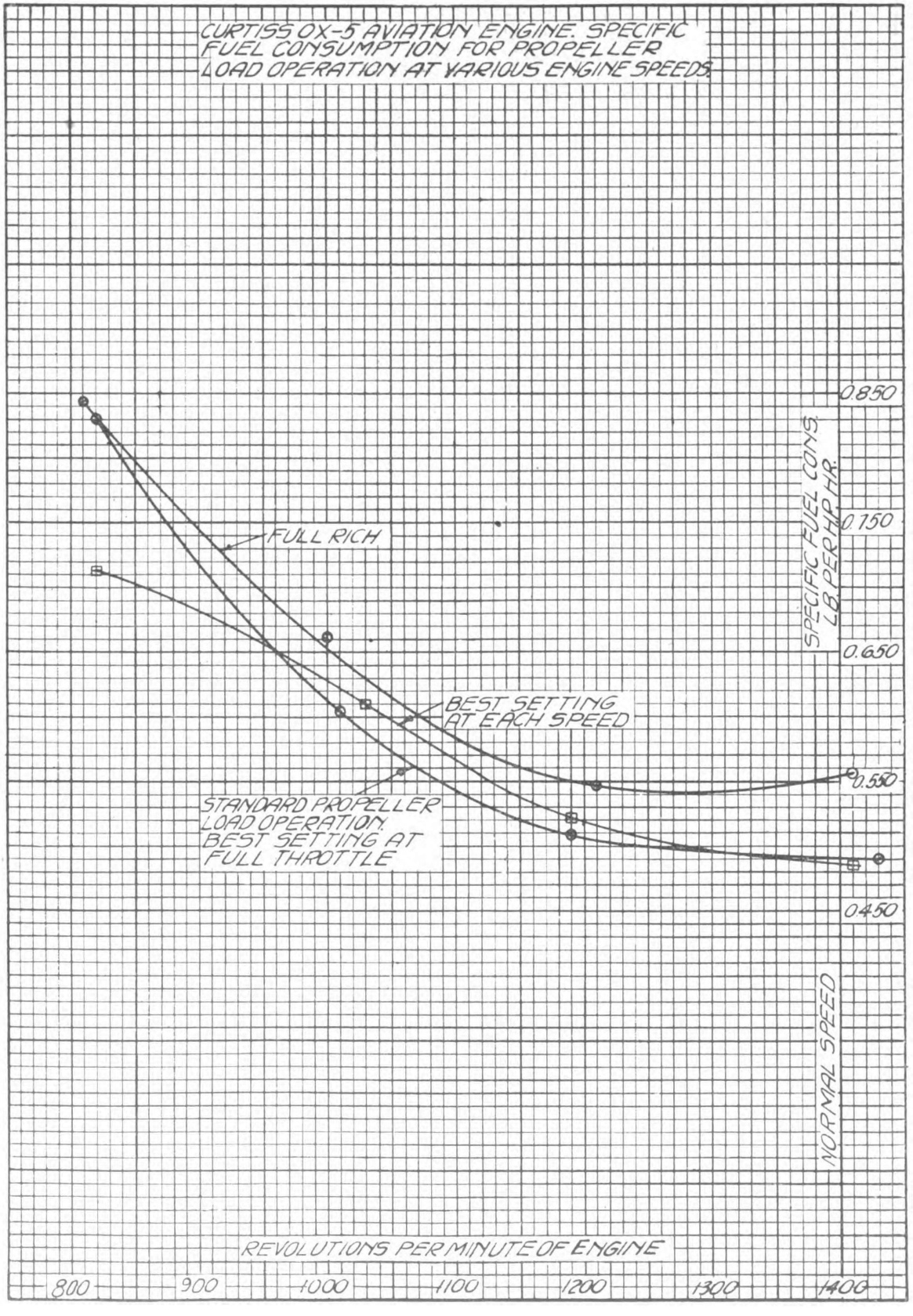

FIGURE 7.

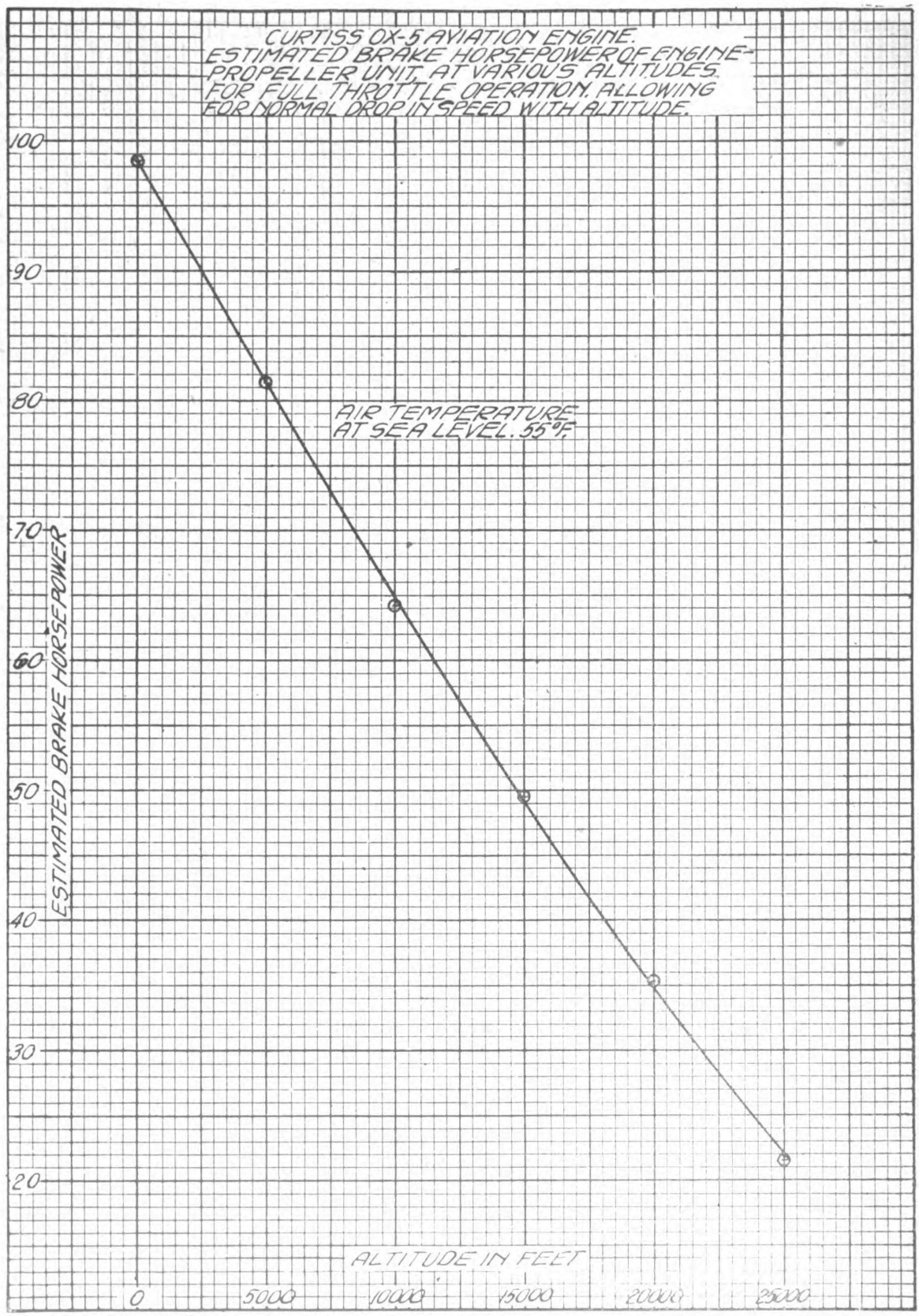

FIGURE 8.